BOTANY.—*Distribution and character of* Sabal louisiana.[1] MIRIAM L. BOMHARD, U. S. Forest Service.

Sabal louisiana (Darby) Bomhard was described under the genus *Chamaerops* in 1816[2] by William Darby, but it escaped the serious attention of botanists until the spring of 1925, when the late Dr. John K. Small rediscovered it. He published it as a new species, *S. deeringiana*, in 1926,[3] for he was not then aware that an earlier name existed. In this paper Dr. Small pointed out that native arborescent palmettos were thought to be lacking along the thousand-mile stretch of the Gulf coast between St. Andrews Bay, Fla., the western limit of *S. palmetto* (Walt.) Lodd., and the lower Rio Grande River near Brownsville, Tex., where *S. texana* (Cook) Becc. is indigenous. The type locality is given as "Flat alluvial places, near Pointe aux Herbes, along Lake Pontchartrain, Louisiana."[4] This is indeed a very restricted area east of New Orleans and slightly northwest of the Chef Menteur (a pass between Lakes Pontchartrain and Borgne).

In a later paper, 1929, following further field work in the general region of Lake Pontchartrain and the Mississippi Delta, Dr. Small wrote: "The geographic limits of *Sabal deeringiana* are not yet perfectly known. It grows in swamps and along bayous in the lower Mississippi delta. It has not been observed east of the Pearl River, nor west of the Atchafalaya River."[5] In his *Manual of the southeastern flora* (1933), the distribution is given as "Flat alluvial places along the lower Mississippi River, bayous and lakes, S. La."[6]

About 1932 I began to make surveys of habitats similar to those in which Louisiana palmetto was rediscovered, as well as in areas mentioned by Darby. The results for Louisiana were published in 1935 and summarized in the following statement: "Although palmettos are widely distributed over much of eastern and southern Louisiana, they attain their most luxuriant development in the southeastern portion of the State, where trunked forms occur. Trunked palmettos are much more widespread in Louisiana at the present time than has been supposed, having been found by the writer westward nearly to Opelousas and south almost to the Gulf of Mexico."[7]

Emphasis was first placed on trunked palmettos because the climax form with a well-developed trunk is easily recognized. For example, the arborescent *Sabal louisiana* specimens standing fairly in the open at Frenier Beach on the west shore of Lake Pontchartrain are so different from other tree-Sabals that the distinctive characters of this species in its prime are unmistakable.[8] Then, too, the most logical approach to an understanding of any arborescent palm species in its native habitat is through observation of the developmental series of a population in the midst of obviously mature trees. Thus, it later became possible to ascertain the identity of groups of *Sabal louisiana* which had not yet attained their prime and with which mature trees were not intermingled.

From observations in Louisiana it seemed apparent that Louisiana palmetto would be

[1] Received March 22, 1943.

[2] DARBY, WILLIAM. *A geographical description of the state of Louisiana . . . being an accompaniment to the map of Louisiana*, ed. 1: 194. 1816.

[3] SMALL, JOHN K. *A new palm from the Mississippi Delta.* Torreya **26**: 33–35. 1926.

[4] There are no Louisiana palmettos in the marshes in the immediate vicinity of Pointe aux Herbes. Those seen by Dr. Small were a distance south of this place.

[5] SMALL, JOHN K. *Palmetto-with-a-stem*—Sabal deeringiana. Journ. New York Bot. Gard. **30**: 283. 1929.

[6] SMALL, JOHN K. *Manual of the southeastern flora*: 240. 1933.

[7] BOMHARD, MIRIAM L. Sabal louisiana, *the correct name for the polymorphic palmetto of Louisiana.* Journ. Washington Acad. Sci. **25** (1): 42. 1935.

[8] The only habit photographs of this species thus far published by others are of specimens at Frenier Beach. See Figs. 5 and 6 in SMALL, JOHN K. (1929), and Figs. 152 and 167 in BAILEY, L. H., *Sabal et ceterae.* Gentes Herbarum III, fasc. VI, art. 6, 1934. Dr. Small's Fig. 6 was republished in his article *Palms of the Continental United States.* Sci. Monthly **32**: 10. 1931. A photograph of a specimen growing near Bayou Bienvenue, eastern Louisiana, was published as Fig. 1 in BOMHARD, MIRIAM L. *What palms grow in Louisiana.* Louisiana Cons. Rev., Autumn, 1937.

distributed throughout the Gulf Coastal Plain (including the Mississippi Alluvial Plain) wherever the physiographic and micro-climatic conditions are essentially the same. Exploration in this broader area, based on this premise, has been carried out since 1935—along the waterways of recent alluvial origin where conditions are reasonably similar to those of southeastern Louisiana and where it could almost be predicted that *Sabal louisiana* would occur.

As a result of these studies the present known range of *Sabal louisiana* has now been considerably extended. From Louisiana this species radiates out into eastern Texas, southeastern Arkansas, and at least into western Florida. The most important extension was the discovery of *Sabal louisiana* in Texas, where it had apparently not been previously observed by botanists.[9] The finding of well-developed arborescent palmettos in that State is especially significant and conclusive.

On a brief trip through eastern Texas in May and June of 1941, two stands of *Sabal louisiana* were discovered south of Cleveland, Tex.—on the western margin of the "Big Thicket." The first, in a local depression just below the town itself, consisted of a dense stand of palmettos, most of them in the intermediate growth stage, with a boot-aggregation of 40 cm or more, leaves 18 dm in expanse, and very robust, strongly branched inflorescences more than 45 dm tall although not yet in bud. This group is similar to many of those in southeastern Louisiana growing under the most favorable environmental conditions.

The second, 4 miles south of Cleveland, within sight from the bridge (U. S. Highway 59) that crosses the East Fork of the San Jacinto River, was a group with arborescent specimens. Perhaps 20 trees are easily accessible, scattered in a rather open portion of the flood bed on the east bank of the river. Farther back, in an area not readily accessible, the large crowns of many other Louisiana palmettos are visible. It was possible to take specimens, measurements, and photographs (Pl. 1, lower left) only of the trees in the open area. The trunk height of these did not exceed 11 dm, and the diameter, without boots, averaged 33 cm. This group is, in many respects, a replica of a stand in the Vermilion River bottomland, near Intracoastal City, southern Louisiana, where short-trunked palmettos remain in clearings nearest the newly made road and the more robust specimens are inaccessible in the midst of woody vegetation, subject to annual inundation.

Another collection of *Sabal louisiana* was found in the bottomlands of the Lavaca River, west of Lolita, Tex. Those nearest the road, although of intermediate character and of uniformly the same age, were so dense and the flood area appeared to be so broad that arborescent specimens in their prime or even old specimens might have been brought to light had there been time to give this region more than a cursory investigation.

Having seen some small groups of poor-looking palmettos (intermediate stage) near the Colorado River, in the vicinity of Wharton, and on the San Bernard River, near Hungerford (U. S. Highway 59), I later made a hasty survey of these same river areas nearer to the coast, this time following State Highway 35, that is, near Bay City and near West Columbia, and also out of East Columbia on the Brazos River. Although conditions here were favorable for arborescent palms, I did not find any in the limited time at my disposal.

However, at least one excellent stand with trunked palmettos does occur in the San Bernard River bottomland 8 miles from Brazoria, Brazoria County. Discovered by Robert A. Vines, of Houston, Tex., these palms were brought to my attention in June, 1942, by C. V. Morton, of the United States National Herbarium, to whom Mr. Vines sent photographs and notes, leaves, and portions of a fruiting stalk of an arborescent *Sabal* for identification. It proved to be *Sabal louisiana*. This discovery of a group of 20 or more of these palms is a fine contribution to the distribution pattern of *Sabal louisiana*, especially since three very old trees are in the group, one with a trunk

[9] See PARKS, H. B., CORY, V. L., and others. *Biological survey of the east Texas big thicket area*, ed. 1, 1936, and ed. 2, 1938. There is a photograph on page 24, captioned "Giant palmetto," but *S. minor* is the only species of this genus given (p. 33) in the list of plants of the big thicket.

height of 54 dm—the greatest height yet recorded for the bole of Louisiana palmetto. A portion of Mr. Vines's notes accompanying the specimens (*Vines* 425) reads as follows: "HABITAT.—Swampy black soil. Associated with *Sabal minor*, *Quercus virginiana*, *Ulmus crassifolia* and *Fraxinus pennsylvanica* var. *lanceolata*. REMARKS.—A palm with a distinct trunk. A handsome palm. Flowers in June and July. Fruit matures in November and December. Evidently very limited in distribution. Eighteen plants found within a half-mile radius. From the number of young plants seen, it was evidently reproducing itself satisfactorily. All the trees grow in thick tangles of vegetation, and are thus protected from excess cold during winter. Old settlers say this small isolated group of palms has been growing wild in the bottomlands as long as they can remember."

Mr. Vines has recently graciously supplied me with his negatives, from which the illustrations in the upper and lower right of Plate 1 were made, as well as with the following additional statement concerning the circumstances of his discovery and locality details:

> The stand of palms grew on the land of Deputy-Sheriff Harold Graves, of Brazoria, Tex. The stand is located on the Brazoria–Cedar Lane cut-off road approximately 2 miles east of the Brazoria and Matagorda County line. The Brazoria–Cedar Lane road runs through the center of the stand. When the road was built some of the workmen dug up some of the large specimens to plant in their yards. According to Deputy-Sheriff Graves and several other of the older settlers, the palms have been there for many years. They remember them as having been in that location for 25 or 30 years. They first remember them when squirrel hunting in the bottomlands as boys, and when rounding up cattle, before the road was ever cut through.
>
> I have also heard rumors of another stand of aborescent palms in the same region. The rumor circulated by old Negro settlers who said they used to see the big palms while fishing on the San Bernard River. None of them, however, could give me exact directions as to just where it might be. I tried several of the leads, but they always were blind ones. I still have a suspicion that at one time quite a large stand must have existed along the San Bernard River. This stand, of course, might have been destroyed, but the rumors, and stories of it, still exist. I still have hopes that I shall be able to rediscover the remnants of the stand eventually.
>
> I first saw these palms, that is, those on the Brazoria–Cedar Lane road, during the summer of 1941, but it was not until the summer of 1942 that I collected specimens and took pictures of them.

Doubtless other arborescent stands will be found in protected areas, where optimum conditions exist, in Texas and other portions of the Coastal Plain.

Louisiana appears to be the center of distribution. Observations thus far made indicate that the greatest concentration of vigorous and thriving stands, including many individuals of arborescent character, occurs in the fertile soils of the lower Mississippi Alluvial Plain. This is partly due to the fact that habitat factors are most favorable for their development and partly because much of this region—in the wetter areas—has not yet been too greatly altered by the destructive forces of man.

The phrase "flat alluvial places" does not, however, convey the true character of the habitat of *Sabal louisiana* even in southeastern Louisiana. Although the areas where it occurs are alluvial, they are not strictly flat. The topography is varied. Account must be taken of the paired alluvial or deltaic ridges, of greater or less width and elevation, that traverse the swamps, marshes, and other low-lying areas. The ridges were formed by alluviation from a series of successively developed distributary channels of the Mississippi River, most of which are no longer active. The land is highest nearest the active or abandoned channels of distributary streams, and slopes toward the wetter areas, characterized by temporary or permanent marshes, swamps, lagoons, or lakes. Louisiana palmetto frequently occurs in the so-called "back land" zone or belt between the ridgeland and the marshes or swamps; it may actually border the wet areas; or if the ridges are of low elevation, it may occupy the ridges themselves usually forming an understory to the other arborescent vegetation. It also occurs in coulees or relict distributionary channels. It is at its best in the mild climate of the Gulf coast, where there is a high water table for much of the year and where partial shade is provided by the surrounding vegetation. It is not a "swamp plant" in the

sense that baldcypress and water tupelo are considered to be swamp trees.

S. louisiana also occurs in the valleys of the Red and Ouachita Rivers, as well as in the Mississippi flood plain proper, where artificial levees and spillways hold the floods in check. In *Louisiana out-of-doors* Percy Viosca, Jr., writes concerning the large interior river valleys, that include hardwood valley lands, river basin swamps, and lakes above Gulf level: "As this region is the richest in the state from an agricultural standpoint, most of it has been cut over, and in place of the forests, today we find sugar cane, corn or cotton fields and truck and dairy farms. Cane is raised more toward the southern part of the state, and cotton more in central and north Louisiana."[10] He states further that palmetto thickets and canebrakes occur on alluvial and "bluff" soils wherever the water table is near the surface.

There is every indication that *S. louisiana* formerly occupied a much larger area than it does today and that there were countless more individuals of tree size. Indeed, William Darby wrote 137 years ago: "The land is commonly of the best quality. Much of the surface of the country low upon the Mississippi, now cultivated in cotton, maize, rice, and sugar, was originally covered with palmetto."[11] Extensive engineering operations, including the building of artificial levees, the closing off of certain natural waterways, the construction of roads, accompanied by clearing of the vegetation and digging of drainage ditches and canals with consequent lowering of the water level, the reclamation of land for cultivation—all have contributed to the disappearance of these palmettos.

This destruction may be witnessed today. The illustration in the upper right of Plate 2 shows the effect of road-building near Intracoastal City, Vermilion Parish, La. The area here occupied by Louisiana palmetto is still rather extensive but it was previously in much more flourishing condition. Dead trunks are lying about on the ground as the result of burning and clearing, and many palms that are still living show charred trunks. The one-time height of the flood level in this area may be noted from the root zone on the trunk just below the "boots" of the small tree illustrated. Fortunately, a distance back of the road, arborescent specimens in their prime with inflorescences overtopping the surrounding vegetation still exist.

The illustration in the upper left of Plate 2 shows a specimen with medium-sized trunk in what was, until a few years ago, a lovely grove of Louisiana palmetto, lying between a natural levee and a cypress-tupelo swamp, near the eastern limit of New Orleans. Many palms were destroyed by clearing and burning, in the process of extensive road-construction and draining, in the general area of Bayou Bienvenue. More recently truck gardening has been initiated in the rich soil of this area, in the midst of chopped and burned palmettos.

In a report of a survey of the Rio Grande River in Texas, Arthur Schott made the following reference, in 1859, to a "gorgeous" growth of palmettos on the Mississippi River: "It is also in the lower portion of this belt (where the Palm tribe is represented by the Chamaerops Palmetto) that the Palmetto attains a growth as gorgeous even as that on the Lower Mississippi; it extends on the Rio Bravo [Rio Grande] up to about 80 miles from the Gulf. In addition to the Palmetto common to the lower portion of these two great rivers, . . . "[12]

In calling attention to Schott's statement, Dr. Small commented: "Field work in the lower Mississippi delta by the writer subsequent to the spring of 1925, has convinced him that the extensive engineering operations connected with the building of the levees along both banks of the river utterly exterminated the palm growth referred to by Schott. Arthur Schott made his observations about the middle of the last century, while extensive levee building occurred about the beginning of the last quarter of that century. It is evident that neither the engineers in charge of the levee work nor

[10] VIOSCA, PERCY, JR. *Louisiana out-of-doors: A Handbook and guide*: 51. 1933.

[11] DARBY, *op. cit.*

[12] SCHOTT, ARTHUR. *Substance of the sketch of the geology of the lower Rio Bravo del Norte*, pt. 2, *in* Emory, William H. *Report on the United States and Mexican boundary survey* 1: 44. 1857.

their associates were botanists, else some record additional to Schott's original statement would have found its way into print."[13] It should be mentioned here that even near the Mississippi itself a few trunked trees of *S. louisiana* occur south of Buras; they have very small crowns and are not now growing in a very favorable situation. Furthermore, the Mississippi Delta occupies a widespread area, and it can be seen from the outline map (Fig. 1) that there are still groups of Louisiana palmetto in many portions of it.

Forty-three years before Schott published the statement quoted above, Darby wrote: "Along both banks of New River, in the rear of the plantations on the Mississippi, and on the banks of the Atchafalaya, are the places where most of the arundo [*Arundinaria gigantea*] yet exists. Here, as well as in every other part of Louisiana, where the land sinks too low for the arundo, is found the *Chamaerops louisiana*.[14]

At the present time, there is still a good representation of Louisiana palmettos between Gonzales, just south of New River, and Sorento, in Ascension Parish. In the lower Atchafalaya Delta arborescent specimens of *S. louisiana* may also be seen today near Morgan City and east of it along Bayous Black and Chacahoula.

Darby described Louisiana palmetto as a new species because he was of the "opinion that there is a specific difference between the *Chamaerops palmetto* hitherto known to botanists, and that of Louisiana."[15] The mistake of Schott, Langlois,[16] Featherman,[17] and others of thinking that Louisiana palmetto was the cabbage tree, *S. palmetto* (=*Chamaerops palmetto* Michx.), does not seem to me to indicate such a serious error in judgment on the part of these observers, but it does show the astuteness of Darby. Certainly this palm could not be the stemless *S. minor* (Jacq.) Pers. To what other arborescent palmetto could it have been referred, considering that Darby's work and publication was apparently not well known and that *S. texana* had not yet been described?

Natural factors also are contributing to changes in the aspect and extent of Louisiana palmetto stands or to their complete obliteration. Two examples—the first on the southwest; the second on the north, shore of Lake Pontchartrain—are of interest. Many of the taller palmettos in the striking group of 35 or more at Frenier Beach (west shore) (2),[18] standing in a coulee back of the lake shore, give the appearance of having been planted for ornamental purposes. There are few transitional forms in this relatively open area, but all stages of growth occur in the low ground to the rear. This beach was built by alluvial deposits; there is a clay base, which, until quite recently, was overlaid with sand. The shore is now being cut back at a rapid rate, geologically speaking. Continued erosion will in the future change the natural habitat. The character and relative abundance of the palms will also be altered as a consequence.

On the north shore, just east of Mandeville (5), a later stage in the squence is taking place. Here the lake, brackish at times, is encroaching upon the land and has already built up a sand ridge, $8\frac{1}{2}$ feet in height, upon the shore. Similar sand-encroachments are taking place in certain other portions of the north shore of Lake Pontchartrain. The extent of swamp was formerly much greater, as attested by cypress stumps about 400 feet out in the lake and dead or dying cypress trees standing at the water's edge. A direct line from the outer margin of the cypress swamp into the lake passes in succession (1) Louisiana palmettos in flourishing condition but with an inconsiderable development of trunk; (2) specimens almost completely buried in the sand, so that only the upper portion of their trunks and crowns is free; and (3) arborescent palmettos standing in a foot or

[13] Small, John K. *Palmetto-with-a-stem*—Sabal deeringiana. Journ. New York Bot. Gard. **30**: 280–281. 1929.

[14] Darby, *op. cit.*, 193–194.

[15] *Ibid.* 194.

[16] Langlois, A. B. *Catalogue provisoire de plantes phanérogames et cryptogames de la Basse-Lousiane, États-Unis d'Amérique*: 17. 1887.

[17] Featherman, A. *Report of botanical survey of southern and central Louisiana made during the year 1870:* 25. 1871.

[18] The figures in parentheses in the text refer to localities on the outline map (Fig. 1).

more of water out in the lake itself. The crowns of the palmettos in the last two groups are much reduced in size, the leaves are thick and very filiferous, and the flower-stalks are telescoped. Eventually this whole stand will be no more, even though new plants will for a time continue to come up between the ridge and the ever-shrinking cypress swamp.

Dr. E. W. Berry states that "the silicified remains of palm wood are exceedingly common in the late Eocene and Oligocene deposits from Texas eastward across Louisiana, Mississippi, and Alabama, and reappear in several of the Greater and Lesser Antilles, as well as in Mexico and on the Isthmus of Panama."[19] Palm leaves are also preserved in certain of these deposits. Various genera are represented, but the correlation of fossils with living genera or species can only be approximate. In the palm family, leaf remains naturally provide more useful identification characters than trunks.

There are fossil deposits containing leaves and "rays" (segments) of *Sabal*-like species in the Jackson formation (Upper Eocene), especially in the Vicksburg limestones and Catahoula and Fayette sands, from eastern Texas to Georgia. Beds of Vicksburg age are notable for the abundance of palm fragments and are of especial interest. The fossil leaf species, *Sabalites vicksburgensis* Berry,[20,21] is described as having a maximum expanse of 120 cm, the rachis continues upward part way through the blade, and the 40 segments, up to 3.6 cm wide, become free in the outer one-third to one-half of the blade. Although the type locality of this fossil species is Rosefield, La. (Catahoula sandstone), it is also abundantly represented in sands of similar age in Fayette, Polk, Trinity, and Webb Counties, Tex. Certain other species of *Sabalites* seem to indicate close relationship with *S. palmetto* or with *S. minor*; it is not improbable that *Sabilites vicksburgensis* may represent an ancestor of *S. louisiana*, which certainly must have been more widespread in geologic time.

Louisiana palmetto, like other species of *Sabal*, evidences a wide range of adaptability to various environmental conditions and, in common with many palms, has different aspects from youth to old age. A consideration of it in four ontogenetic stages—juvenile, intermediate, climax or mature, and senescent—should contribute to a better understanding of this species.

Apparently there are comparatively few senescent Louisiana palmettos in existence, and all that I have seen in Louisiana are, or appear to be, growing in habitats that are no longer entirely favorable. Only an approximation of their age is possible but it is known that this species grows slowly. An ancient tree, such as that illustrated in the upper left of Plate 1, may well be 200 or more years of age. Four (occasionally eight) leaves are produced by *S. louisiana* in a season; the leafscars on the trunk are very close together. It is not determinable what length of time elapses in the production of the horizontal underground stem before the erect habit is assumed.

A reduced leafcrown—smaller blades on shorter petioles—and shortened, telescoped inflorescences are indications of senescence or induced senescence. Thus, the total height of an old specimen with relatively tall trunk is often less than that of a specimen in its prime with much shorter bole. The more robust appearance of the younger palmettos in the photograph is evident as is also the contrast between the senescent tree and the young climax form at the left.

This group (Pl. 1, upper left) is part of the largest single Louisiana palmetto area of which I am aware, but I have not seen more than a half-dozen senescent specimens in it. Thousands of palmettos, the majority in the intermediate and climax stages, occupy an almost unbroken stretch of at least 20 miles from Golden Meadow to a distance south of Leeville, La., along Bayou Lafourche (14). This bayou no longer functions as a distributary of the Mississippi River, having been closed off from it in 1912. The broader alluvial regions in the upper por-

[19] BERRY, E. W. *The flora of the Catahoula sandstone.* (M) in *Shorter contributions to general geology*, 1916. U. S. Geol. Surv. Prof. Paper 98: 233. 1917.

[20] *Ibid.*

[21] BERRY, E. W. *The Middle and Upper Eocene floras of southeastern North America.* U. S. Geol. Surv. Prof. Paper 92: 151, pl. 29. 1924.

tion of its course are under cultivation. The palmettos are to be seen in the lower portion. They occupy a relatively narrow, almost treeless zone between the ridge-road and swamp or marsh, or they occur as an understory on the chéniêres. These ridges near the coast, on which live oak (*Quercus virginiana*), water oak (*Q. nigra*), and hackberry (*Celtis laevigata*) form the dominant vegetation, take their name from the French *chéne*, oak. The palmetto growth fades out together with the diminishing chéniêres toward the Gulf of Mexico.

The few senescent specimens in this large tract closely resemble each other; some have more boots clinging just under the crown. A dense mass of roots clothes the lower 4.5 dm or less at the base of all of them. The trunks are almost white—a modification in this saline situation, where the insolation is intense, of the normally grayish-brown tone of the bark of this species. The longitudinal fissures that cross the closely spaced leafscars lend a checkered appearance to the bark.

In Louisiana old palmetto individuals also occur near Bayou Bienvenue (3) and near the Mississippi River on Bayou Laird, south of Buras (15); the trees, partly buried in the sand ridge on the north shore of Lake Pontchartrain (5) and with only 75 cm of visible trunk, are also senescent. Measurements in these scattered localities are very similar and may be summarized as follows: Trunk: Height, 15–26.5 dm (up to 54 dm in Texas); diameter of trunk devoid of boots, 22.6–28 cm. Leaf blade: Expanse, 10.5–13 dm; length in middle line, 6.5–9 dm; rachis length, 15–26 cm; number of segments, 34–40; widest segments, 3.8–5.7 cm; sparsely to very filiferous in the sinuses, depending upon the habitat. Petiole: Length, 50–80 cm; width near blade, 2.2–2.9 cm; width near base, 2.8–3.8 cm. Inflorescence: Height, 12–27 dm; width at base of inflorescence stalk, 3.2–7.6 cm; number of sterile spathes, 10; number of fertile spathes, 7–13.

The specimen illustrated in the upper right of Plate 1 was photographed by Mr. Vines in the San Bernard River bottoms (28) of Texas. Three trees in this area are old, the tallest trunk measuring 54 dm. The diameter averages 30 cm. This locality appears to represent a more nearly normal habitat for *S. louisiana* than any of the areas in Louisiana where old trees have been observed. The crown shows reduction in size, but the leaves appear to be larger and the petioles are longer than those whose measurements have just been listed. This is to be expected where palms occur in an undisturbed wet area in "thick tangles of vegetation." Sudden lowering of the water table has apparently not occurred in this region and it is probable that complete drying out of the terrain does not take place. This venerable group should continue to be protected. It is highly desirable that certain groups of Louisiana palmetto in Louisiana should be set aside for conservation, inasmuch as stands of this sort are imminently threatened with extinction.

Louisiana palmetto evidences the full vigor of maturity in the climax stage. The few descriptions of this species thus far published apply, with some emendations, to this life-form. Ordinarily the climax stage is a bulky palm, with heavy, impressive crown, but its appearance varies somewhat with habitat just as do other phases of this species. Plate 1, lower left and lower right, illustrates typical specimens in Texas (27 and 28). The most typical specimens in

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Plate 1.—Upper left: Senescent *S. louisiana*, surrounded by palmettos of intermediate growth stage with boot-aggregation, and young climax forms with short trunks such as that to the left of the old tree. In an open situation where the habitat is no longer entirely favorable, along Bayou Lafourche, near Leeville, La. (15).

Upper right: Senescent *S. louisiana*, with trunk height of 51 dm. In an apparently optimum habitat, San Bernard River bottoms, 8 miles west of Brazoria, Tex. (29). Photograph by Robert A. Vines.

Lower left: Louisiana palmetto of climax form. Upper portion of trunk and lower part of crown. Open bottomland, East Fork of the San Jacinto River, south of Cleveland, Tex. (27).

Lower right: Vigorous climax specimen that has retained the leaf bases in a favorable, protected habitat. Mr. Vines, who discovered and photographed this stand, is holding a leaf cut from a younger climax palmetto growing nearby. San Bernard River bottoms, 8 miles west of Brazoria, Tex. (29).

PLATE 1.—(See opposite page for explanation.)

PLATE 2.—Upper left: Typical young climax form of *S. louisiana*. Near Paris Road, vicinity of Bayou Bienvenue, La. (3).

Upper right: Climax Louisiana palmetto, showing the effects of burning and clearing in connection with road-construction. Sawed palmetto trunks in the left foreground. Near Intracoastal City, La. (16).

Lower right: "Field type" of intermediate growth stage, showing the characteristic collapse of the dying leaves. Along a fence bordering a cottonfield, Rayville, La. (35).

Bottom: A group of palmettos in intermediate growth stage toward the northern limit of the range of *S. louisiana*. The strongly branched inflorescences are not yet in bud (May 23, 1941). West of Montrose, Ark. (23).

southern Louisiana, such as that shown in the upper left of Plate 2, grow in partial shade on moist fresh-water sites that are flooded in winter and in early spring. In the lower-lying areas Louisiana palmetto is associated with willows (principally *Salix nigra*), red maple (*Acer rubrum drummondii*), and ashes (*Fraxinus caroliniana*, *F. tomentosa*, or *F. pennsylvanica lanceolata*), not far removed from the deeper swamps dominated by baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*, usually known as tupelogum) or swamp blackgum (*N. biflora*). On the ridges, dominated by live oak and hackberry and sometimes also southern magnolia (*Magnolia grandiflora*), the other arborescent associates of Louisiana palmetto include American sweetgum (*Liquidambar styraciflua*), water oak (*Quercus nigra*), willow oak (*Q. phellos*), waterelm (*Planera aquatica*), and American hornbeam (*Carpinus caroliniana*). Common honeylocust (*Gleditsia triacanthos*) or yaupon (*Ilex vomitoria*) is also frequently present.

In the interior river valleys of central and northern Louisiana tree communities of the wetter areas are, on the whole, similar to those farther south. Several additional species of oak, such as red oak (*Q. shumardi*), Nuttall oak (*Q. nuttalli*), and overcup oak (*Q. lyrata*), pecan (*Carya pecan*), winged elm (*Ulmus alata*), and other hardwoods augment the list of tree associates that occur with Louisiana palmetto on the ridgelands farther from the coast.

In optimum habitats a characteristic specimen of Louisiana palmetto with medium-sized trunk has large, comparatively thin, bluish-green leaves up to 20 dm broad. The length in the middle line is 9 dm or more; but this is somewhat shorter than the maximum blade length in either side of the center. The pinnati-palmate leaves are not in one plane. The blades have a characteristic "palmetto-curve," but it is not so strongly developed as in *S. palmetto* and other large-leaved arborescent Sabals. The rachis (continuation of the petiole as a midrib into the blade, along which most of the segments originate) is winged below and firmly supports the lower one-third of the blade, but, beyond it, the leaf is deeply split into two halves. From 36–50 segments divide the outer half or two-thirds of the blade, the inner solid portion being broadly heart-shaped in outline with the notch at the top, at the end of the rachis. The broad, gradually acuminate segments stand out rather stiffly; their apices, although bifid from several to 13 cm (or even more at the sides), are usually not flaccid. A thread-like fiber hangs in the clefts of the younger leaves but only a few persist in older ones. The flat, platelike hastula, at the juncture of the petiole and blade on the upper surface of the leaf, is asymmetrical and averages 4 cm in length.

The unarmed petioles, longer than the blades, are concave on their upper and rounded on their lower surfaces; the upturned margins are very sharp, faintly denticulate toward the base. The peitole bases split with age but only occasionally form a crisscross or lattice (so characteristic of the larger *Sabal* species). The two boot-halves remain erect or at least ascending for a considerable period. The sheaths are never prominent; in fact, they are noticeable only in the youngest part of the crown, where the petiole bases of the newest leaves are bordered by narrow, chaffy, light brown margins.

One of the most interesting characteristics of this species is the peculiar collapse of the dying leaves at the juncture of the petiole and blade, giving the effect of a half-closed umbrella. The blade may fall off at this point, or the petiole may break midway before the blade falls.

A trunk averaging 9–18 dm in height usually exhibits three zones: a region of roots at the base, a narrow girdle of bark, and a boot area below the leafcrown. Occasionally an additional root development occurs fairly high up on the trunk, indicating some previous high water level. (Compare the illustration in the upper right of Plate 2 with that in the upper left.) The actual trunk diameter (bark only) rarely exceeds 33 cm and is usually somewhat less. When the boots persist over a period of years, as often happens in the wetter situations, the trunk appears to be twice as thick as it actually is. The rough bark is usually grayish brown.

Four to six (generally four) inflorescences ("spadices" of literature) are produced in a season. They stand stiffly erect and, in the more open situations, may surpass the associated small trees. Twenty-two or more tubular, long-pointed spathes overlap each other and cover the length of the inflorescence axis. Those in the lower stalklike portion of the axis are sterile; the upper, fertile. *S. louisiana* is characterized by a thrice-compound inflorescence—the strongly developed, ascending or appressed, lateral branches that emerge from the lower fertile spathes may attain 9 dm in length in the climax form. The branches become progressively shorter until, toward the apex of the main inflorescence, the panicles emerge directly from the uppermost fertile spathes. The lower branches have five or fewer sterile spathelets at their base and the ten or fewer panicles are subtended by the upper fertile spathelets.

The young inflorescence shoots are visible in the leafcrown in November. These are elongated, attenuate-coniform structures, imbricated with the appressed apices of the lower spathes. Full development is not attained until the following spring. Flowering begins in June, or even late in May, and sometimes continues into July. In some years full flowering fails to take place, even on perfectly vigorous specimens, because of unusual infestation of the panicle buds by insect larvae. Some of the lower panicles of the branches may come into flower but the remainder are aborted. In 1933 only one palmetto tree in a stand of 40 or more bore normal inflorescences.

The flowers are white, sessile, 5–6 mm high, spirally placed about the rachillae at rather regular intervals, spaced several millimeters apart. They are subtended by two unequal bracteoles, the base of the smaller being partially enclosed by the larger. Floral characters are: calyx 2–2.5 mm high, cylindric and thick below, 3-angled, with three short, triangular, unequal, slightly carinate, thin, nerved lobes; corolla more or less united with the stamens into a short pseudotube at base; petals 3, broadly ovate, 3.3–3.5 mm high, 2 mm broad at base, thin, involute, minutely serrulate, thickened and hooded at apex, auricled at based, 5–7 nerved; stamens 6, the alternate shorter than the opposite that are adnate to the petals; filaments subulate-lanceolate, dorsoventrally flattened; opposite stamens 4.5–5 mm high, the filaments 4 mm high, 1 mm broad at base; alternate stamens 4–4.5 mm high, filaments 3.5 mm high, less than 1 mm broad at base; anthers bright yellow, introrse, short-sagittate, 1–1.2 mm long, anther sacs somewhat unequal; pistil comprised of 3 carpels, 3.5–4 mm high, 1 mm or more broad at the enlarged ovarial base, stylar portion 3-angled, apex truncate. The flower buds show 18 chromosomes (plate stage).[22]

The fruits are suborbicular, brownish black drupes, ripening in November. They average 9–11 mm in diameter and 8–9.5 mm in height. The reddish brown, sub-lustrous seeds, enclosed in a thin integument, are 8–9 mm in diameter and 6–7 mm in height. The micropyle is lateral.

Many of the fine groups of climax specimens along Bayou Sauvage and near the Chef Menteur (1 and 4), including some of those on which Dr. Small based his original description of *S. deeringiana*, are, unfortunately, no longer extant. However, favorable localities in Louisiana where numbers of characteristically well-developed climax specimens may still be observed are at Frenier Beach (2), near Bayou Bienvenue (3), in the lower portion of the Vermilion River bottom (16), along Bayou des Allemands (11), east of Berwick Bay on Bayous Black and Chacahoula and south of it on Bayou Shaffer (15), and in some other places (1, 12, 14). Fairly isolated individuals in their prime, noted in Louisiana, near the towns of Bunkie (19), Denham Springs (17), and Rayville (22), will be discussed in connection with Louisiana palmettos of intermediate growth stage. In Alabama a good stand of representative Louisiana palmettos grows in the bottomland of the Tensas River at the head of Mobile Bay,

[22] Dr. A. E. Longley, U. S. Department of Agriculture, obligingly examined many samples of Louisiana palmetto flower buds that had been collected in various localities. Only those from the Chef Menteur area along Bayou Sauvage proved to be in the proper stage for chromosome counts. They were collected from both climax and intermediate forms of *S. louisiana*.

in a locality inaccessible except by descent from the Louisville & Nashville Railroad trestle (24). The best groups thus far discovered in Texas have already been mentioned as occurring in the bottomland of the East Fork of the San Jacinto River (27) and in that of the San Bernard River (28).

Measurements of the climax form may be stated as follows: TRUNK: Height 9–19.5 dm; diameter of trunk devoid of boots, 28–34 cm. LEAF BLADE: Expanse, 16.5–20 dm; length in middle line, 9–12 dm; rachis length, 25–42.5 cm (usually 30–37.5 cm); number of segments 36–50 (usually 38–42); widest segments, 4.7–7 cm; usually sparsely filiferous. PETIOLE: Length, 70–145 cm (usually 105–135 cm); width nearest blade, 2–3.8 cm; width nearest base, 4.5–5.7 cm. INFLORESCENCE: Height, 25.5–39 dm (usually 36 dm); width at base of inflorescence stalk, 4.5–6.4 cm; number of sterile spathes, 10–14; fertile spathes, 12–18; lower inflorescence branches up to 9 dm in length.

Deviations from the characteristic climax form of the shaded, fresh-water sites are especially apparent in the extensive Bayou Lafourche palmetto area (14), evidencing adaptation to a different set of environmental factors. The leafblades are thicker in texture, glaucous, stiffer, yellow- or gray-green, and abundantly filiferous; the inflorescences average 30 dm in height; and the trunk diameter is not quite 28 cm.

Under favorable conditions there is a natural transition from the climax form to those of intermediate stage. It is so gradual that the line of demarcation has been arbitrarily placed to include in the intermediate stage those specimens whose trunks usually retain the leafbases to form "boot-aggregations" of 9 dm or less, and that do not yet show a true bark area. There is also no visible root development above the ground level. The leafblades are borne on longer petioles and are frequently larger than those in the climax form; they are ordinarily 3 dm broader in proportion to their length. The tallest inflorescences with the most strongly developed lower branches (up to 15 dm in length) also occur in this stage.

Palmettos of this robust intermediate stage occur in most of the optimum areas already given for the climax form. However, certain additional localities in which the palmetto population is predominantly or entirely composed of flourishing specimens in this and juvenile stages are of interest. These palmetto areas are indicated on the outline map by numbers 6, 7, 8, 9, 13, 18, 20, and 21 for Louisiana, 23 in Arkansas, and 26 and 29 in Texas. There is the possibility, of course, that climax forms are associated with the intermediate forms in the more inaccessible wetter portions of some of these areas but have not yet been discovered. In other populations, it is known that the larger palmettos were removed in the clearing of the forests for cultivation of sugar, cotton, or other crops. Where cultivation was later abandoned and the areas permitted to return undisturbed to forest, second growth timber has come in. In such places, provided that the water level is still near the surface, all the palmettos are of normal intermediate or younger growth stage.

Louisiana palmettos of the intermediate growth stage in normal environments have the following dimensions: TRUNK: Height, 3–9 dm. LEAF BLADE: Expanse, 12–21.5 dm; length in middle line, 8–11 dm; rachis length, 16.7–42 cm; number of segments, 34–50 (averaging 34–42); widest segments, 2.2–6.7 cm; sparsely to moderately filiferous. PETIOLE: Length, 95–160 cm; width nearest blade, 2.5–4.5 cm; width near base, 3.2–5.7 cm. INFLORESCENCE: Height, 27–46 dm; width at base of inflorescence stalk, 3.8–6.4 cm; number of sterile spathes, 9–11; number of fertile spathes, 11–17; length of lowest branch, up to 15 dm.

An unfavorable environment is reflected in the character of intermediate-stage palmetto groups subjected to adverse natural factors such as saline or brackish water, excessive direct sunlight, and the piling up about the plant bases—or removal therefrom—of soil and inundation debris. The great majority of the Louisiana palmettos of intermediate stage that grow in deep muck in exposed brackish habitats along Bayou Lafourche (14), some of those on the lake side of the sand ridge at Lake Pontchartrain (2), and the few specimens in sand on the east shore near the mouth of the Escam-

bia River, Fla. (25), show the effects of naturally trying conditions and closely resemble each other.

The character of Louisiana palmettoes in or near pastures, cultivated fields, or fields turned back to pasture is also associated with unfavorable environmental conditions, but these have been mainly brought about by the clearing of forests together with lowering of the water level, plowing or other methods of cultivation, and cattle-grazing. High insolation and long dry periods following brief or only occasional high water levels are contributing adverse factors. In the more northern latitudes the cooler winter temperature also exerts a retarding influence upon growth.

The growth form of all these palmettos in the intermediate stage is compact—the crown is less open and smaller than in those in optimum habitats, and the aggregation of boots at the base is very dense, probably because elongation of the upright trunk proceeds very slowly. The "palmetto-curve" of the thick, more or less glaucous, yellow- or gray-green, abundantly filiferous leaves is more prominent, as is the inclination of the two halves of the blade away from the middle line. The segments are relatively wider in proportion to the size of the blade. The characteristic umbrella-collapse of the dying leaves is pronounced (Pl. 2, lower right). From a distance, pastures and cut-over areas of palmettos resemble fields of shocked wheat. The thick, branched inflorescences are shortened and compressed, often being very similar to those of senescent trees. The lower branches are so close together in many of the field and pasture palmettos that the inflorescences have a bushlike appearance. Failure to develop inflorescences is not infrequent in palmettos that are exposed to grazing, plowing, etc., but those along fence rows and the margins of fields that border woods succeed in putting forth inflorescences in occasional years, if not annually.

Although the palmettos in naturally adverse habitats (2, 14, and 25) have somewhat larger leaves and boot-aggregations (3–6 dm) in contrast to the smaller leaves and boot-aggregations (about 3 dm) of the intermediate stage of fields and pastures (30, 31, 32, 33, 34, 35, 38, 39), the overall dimensions fall within the same range: TRUNK: Height of boot-aggregation, 3–6 dm. LEAF BLADE: Expanse, 12–15 dm; length in middle line, 6.7–9.2 dm; rachis length, 13–22 cm; number of segments, 32–40 (usually 32–38); widest segments, 3.8–5.7 cm; very filiferous. PETIOLE: Length, 45–95 cm; width nearest blade, 2–4.5 cm; width near base, 2.8–5.7 cm. INFLORESCENCE: Height, 20–28.5 dm; width at base of inflorescence stalk, 3.2–5 cm; number of sterile spathes, 9–12; number of fertile spathes, 10–17; length of lowest branches, up to 4.5 dm.

The palmettos, with boot-aggregations and branched inflorescences, that grow in certain cultivated alluvial areas of Louisiana have not previously been identified as *S. louisiana*, but they represent an intermediate stage just as surely as do the luxuriant specimens of intermediate form in favorable localities where the relationship is more obvious.

The stocky specimens growing in the open in pastures or abandoned fields, especially in central and northern Louisiana, frequently occur in large numbers. A succession to more vigorous palmettos of intermediate stage but still of the "field type," may sometimes be traced from these open palmetto areas to the lower-lying, wetter margins of the pastures or fields, neighboring woodlands, or up to the edge of small streams.

The discovery of three arborescent palmettoes in widely separated localities in Louisiana, where most of the surrounding countryside has long since been cleared and put under cultivation, not only suggests that arborescent Louisiana palmettos were formerly more common than now, but also, in my judgment, has a vital bearing upon the relationship of the intermediate-stage palmettos that grow in pastures and fields.

The first of these three individuals occurs in a deep woods just east of Denham Springs (17). When I last saw it several years ago, the trunk height was 14 dm, the leaves were 13 dm broad, and the inflorescences attained 36 dm in height—a typical climax specimen. It grew near a bayou branch of the Amite River that is consider-